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ABSTRACT

This study analyzes the effects of one environmental property, illumination, as part of a general program to isolate differential effects of specific properties of the novel environment on attachment behaviors in infants and young children. Attachment is operationalized into two response classes: (1) proximity to the mother, and (2) contact with her. Twenty female infants within each of 5 age groups (between 8 and 24 months) were randomly assinged to one of two experimental groups who were exposed to novel environments with high or low levels of illumination. Within each condition, subjects were observed in a series of six 3-minute eipsodes presented in a standard order for all infants. Analysis of results indicates that illumination does influence attachment behaviors, with the direction of the effect varying the type of attachment behavior involved. Discussion focuses on various theoretical interpretations of the data. (DP)

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Effects of Illumination on Attachment Behaviors in a Novel Environment[1]

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An assumption shared by a number of investigators, ranging from Arsenian in 1943 to Ainsworth, Rheingold and their coworkers within the contemporary scene, is that a novel environment usually referred to as a "strange situation" functions as an activating condition for attachment behaviors among infants and young children. Recent studies on the effect of environment novelty by Rosenthal (1967), Rheingold (1969), Ainsworth and Wittig (1969), and Ainsworth and Bell (1970) have consistently demonstrated that infants left alone in a strange situation manifest crying, increased proximity-seeking, and response decrements in exploration, play, and speech. Nonetheless, the differential effects on attachment behaviors of specific properties of the novel environment still have to be delineated. The aim of the present study was to investigate the effects of one property, namely, illumination, on attachment behaviors manifested within a novel environment. Illumination was chosen because it lends itself easily to experimental manipulation and because of available data suggesting that it might have an influence on attachment behaviors.

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The findings reported by Rheingold and Eckerman (1970) regarding environmental stimuli which attract infants away from their mothers suggest that properties of the ambient enviornment such as illumination intensity may affect the infant's leaving his mother. Conversely, such environmental properties may also influence proximity-seeking. If so, it would be

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important to assess how variations in illumination intensity in a novel environment might affect attachment behaviors.

In the present study, attachment behaviors, were viewed as classifiable within two response classes: (1) proximity behaviors, the effect of which is to maintain a particular spatiotemporal relationship between mother and infant, and (2) contact behaviors, the effect of which is to allow the infant to experience the mother's presence, and vice versa. It was assumed that there is a developmental progression from reliance on signalling to approach behaviors as a means of maintaining proximity to a visible mother, and from signalling to search in maintaining proximity to an absent mother. For contact behaviors, the developmental progression is from sensorimotoric to perceptual behaviors, and, at a later phase, to conceptual-symbolic behaviors as the dominant means for establishing contact with the mother. Among the perceptual means, the shift is from tactual to visual and auditory types of contact. These changes in dominance among the means for maintaining proximity or establishing contact with the mother represent shifts in levels of functioning in attachment behaviors. Based on certain assumptions within organismic developmental theory, it was hypothesized that within a novel environment under high illumination, infants would maintain proximity to and establish contact with their mothers at their highest level of development with respect to the means for attaining these goals; under low illumination, infants would employ means characteristic of an earlier level of functioning in maintaining proximity to and establishing contact with their mothers.

Methodology

Twenty female infants within each of five age groups were randomly assigned to one of two experimental groups who were exposed, respectively

to a novel environment with high illumination and to a novel environment with low illumination. All infants were capable of locomotion and were within 7 days of being 8, 11, 14, 19, and 24 months of age at time of testing.

The novel environment was a university experimental room subdivided into 3 compartments, adjacent to an observation room with a one-way vision mirror window. From the "starting room" where mother and infant were initially observed, the infant could view the mother's entry into the next room, designated "passage," but not her further progress into the third and "hiding room" which had (1) a door which could be locked so that the infant could not gain access to the mother while the latter was inside, and (2) an opening through which the mother could present her face to the infant.

To create a novel environment, the walls and floor of the experimental room were covered with corrugated cardboard which had a checkerboard design with black and white 6-inch squares. The only furniture were a chair for the mother and a small table on which a disguised tape recorder was placed. In order to increase the degree of novelty, familiar objects presented in a novel manner were introduced.

Overhead lighting from four lamp globes provided the illumination which, expressed in foot candles, was 12.8 and 3.2 in the high and low illumination conditions, respectively.

Within each illumination condition, subjects were observed individually in a series of six three-mintue episodes presented in a standard order for all subjects. These episodes, designed to elicit infant attachment behaviors under varying experiences of the mother's presence may be characterized as follows:

1. Mother is in the same room with the infant, not actively interacting but responsive to interactions initiated by infant.

2. Mother's pocketbook is visible to infant but mother herself is in hiding in Room H.

3. Mother's voice is heard by infant while mother remains in hiding in Room H.

4. Mother's face is presented to infant from a window in Room H.

5. Mother returns to the compartment where infant is located.

6. Mother is in the same room with the infant, not actively interacting but responsive to interactions initiated by the infants.

All attachment behaviors manifested at ten-second intervals were recorded by the experimenter on a tape recorder which also picked up every ten seconds a click of an electric timer. To establish observer reliability, 20% of the sample was jointly observed by the experimenter and a trained observer. Signalling, approach, and search behaviors were the types of proximity behavior observed. For contact behaviors, sensorimotoric, perceptual (auditory, tactual, and visual), and conceptual-symbolic behaviors were recorded.

For each proximity or contact behavior, two scores - total frequency per minute and proportion score per minute - were computed and submitted to a statistical analysis, except for auditory and conceptual-symbolic responses which were very few. A total frequency score per minute was obtained by adding the number of ten-second intervals during which the behavior occurred for every minute of each pertinent three-minute episode. To determine the inter-relationships among types of proximity or contact behavior, proportion scores for each type were computed. To obtain a proportion score, a subject's frequency score on a given minute for a particular type of proximity or contact behavior was divided by the total number of proximity or contact behaviors for that minute. Since the six episodes did not

provide equal opportunities for the display of all proximity or contact behaviors, frequency scores which were converted into proportions were taken only from those episodes which afforded opportunities for the manifestation of all the particular proximity or contact behaviors being compared. Because there were zero frequency scores, a square-root transformation (Kirk, 1968) was performed on all frequency scores before the proportion scores were computed.

In order to test the hypotheses set forth in this study, analyses of variance were performed on the total frequency scores per minute and on the proportion scores per minute obtained by the subjects for each of the three types of proximity behavior and for three types of contact behavior, namely, sensorimotoric, tactual, and visual behaviors. To assess differences in attachment behavior under two intensities of illumination, a split plot repeated measures design with two between factors (age and illumination) and two within factors (episode and minute) was carried out.

Results

Changes in levels of functioning in attachment behaviors were assessed through changes in the proportion scores for each type of attachment behavior. To the extent that a proportion score denotes a relationship between types of proximity or contact behaviors representing varying levels of functioning, then significant differences in proportion scores obtained under high versus low illumination could be indicative of changes in levels of functioning. Only the results from the analyses of proportions will be reported, excpet when such results can be clarified by a consideration of findings concerning frequency scores.

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Illumination had a significant effect on the proportion of signalling ($F = 6.39$, $df = 1, 90$, $p < .05$), in the direction of an increase in signalling proportions under low illumination. The main effect of illumination was modified by a significant Age x Illumination x Episode interaction ($F = 2.75$, $df = 1, 90$, $p < .05$). The proportion of signalling did not consistently increase under low illumination for all age groups nor in all episodes; only the 14- and 19-months-olds clearly showed a trend towards higher proportions of signalling in the low versus high illumination condition, and the difference reached an acceptable level of significance only for the 19-month-old children in Episode 2. The mean proportion of signalling manifested by this age group during the mother's absence was significantly higher under low (0.68) versus high (0.38) illumination.

The analysis of variance on proportions of approach did not yield any significant main effect of illumination nor significant interactions between illumination and age or episode. The Age x Illumination x Episode interaction was statistically significant ($F = 2.81$, $df = 12, 270$, $p < .001$), but paired comparisons of the mean proportions of approach manifested under high versus low illumination by each age group within a particular episode failed to reveal any differential approach behaviors associated with level of illumination.

The prediction with respect to the effect of illumination on search behavior was that infants who had attained a level at which search was used as a means of regaining proximity to an absent mother would search less in the low as opposed to the high illumination condition. A statistically significant F score for illumination ($F = 6.31$, $df = 1, 90$, $p < .05$) was obtained from the analysis of variance on proportions of search behaviors. The main effect ofillumination was a decrease in the proportion of search

behaviors shown under low illumination. However, this effect was qualified by significant interactions between age and illumination ($F = 2.98$, $df = 1, 90$. $p < .05$) and Age x Illumination x Episode ($F = 3.71$, $df = 4, 90$, $p < .01$). Although the proportion of search to total proximity behaviors tended to be lower in the low illumination condition, the difference was statistically significant only for the 19-month-old children in Episode 2($\bar{X} = 0.62$ under high and $\bar{X} = 0.32$ under low illumination).

The prediction with respect to contact behaviors was that proportions of sensorimotoric and tactual contact behaviors would increase while visual contact behaviors would decrease under low versus high illumination. The analysis of variance on proportions of sensorimotoric behaviors revealed a significant effect of illumination ($F = 3.42$, $df = 1,90$, $p < .05$). Contrary to expectation, infants used a lower mean proportion of sensorimotoric behaviors in establishing contact with their mothers when the illumination was low as opposed to when it was high, across age groups. For proportions of sensorimotoric contact, the Illumination x Episode interaction was also significant ($F = 5.15$, $df = 2, 180$. $p < .01$). A significantly higher mean proportion of tactual contact behaviors was exhibited under low (0.35) than under high (0.29) illumination ($F = 25.24$, $df = 1, 90$, $p < .001$). For proportions of tactual contact, the Illumination x Episode interaction was also significant ($F = 6.24$, $df = 2, 180$, $p < .01$). The proportions of visual contact varied significantly with illumination, too ($F = 18.17$, $df = 1, 90$, $p < .001$). Overall, the mean proportion of visual contact behaviors was consistently less under low (0.39) versus high (0.44) illumination. However, a significant Illumination x Episode interaction ($F = 4.39$, $df = 2, 180$, $p < .01$) was also obtained.

To recapitulate, insofar as proximity behaviors are concerned, there is some support for the hypothesized shift toward an earlier level of functioning under low illumination, as indicated by the increment in proportions of signalling and the decrement in proportions of search. A significant change in the proportion of approach behavior was not obtained. Although there was an increase in the frequency of approach behavior in the low illumination condition, there was a concommittant increase in signalling frequencies so the approach proportion scores did not change appreciably. For contact behaviors, there was some apparent support for the prediction that, under low illumination, there would be a decrease in the proportion of visual contact behaviors and an increase in the proportion of tactual contact behaviors. To the degree that tactual behavior is a genetically earlier means of maintaining contact, the prediction that there would be a shift to a lower level of functioning is supported. Unexpectedly, sensorimotoric contact behaviors decreased rather than increased in the low illumination condition.

Discussion

The results of the present study have implications for conceptualizing the relationship between environment novelty and the activation of attachment behaviors. They indicate that one property of the ambient enviornment which influences attachment behaviors is illumination, with the direction of the effect varying with the type of attachment behavior.

In general, the illumination effect can be explained in several ways From an ethological point of view, it might be said that there is a genetically programmed tendency for infants to maintain closer proximity and contact with their mothers under low illumination, because such behaviors would maximize survival. Another explanation can be derived from Berlyne's theory of arousal (1960). According to this theory, changes in illumination

intensity create uncertainty or cognitive conflict which co-occurs with a heightened state of arousal which, in turn, is associated with increased responding. The type of response varies with the direction of the change in illumination intensity. In this particular case, exposure to a level of illumination lower than normal daytime lighting led to an increment in attachment behaviors; if the shift had been to a higher level, the outcome might have been increased exploration. Perhaps, the most parsimonious explanation is available within Lazarus' (1966) thinking about psychological stress and coping mechanisms. From this point of view, illumination intensity is conceptualized as a stress-inducing variable, reacted to by infants with efficient or nonefficient coping mechanisms, represented by proximity and contact behaviors. Within this context, attachment behavior functions as a coping mechanism against a perceived threat.

The specific findings pertaining to changes in level of functioning, that is, from search to signalling within proximity behaviors and from visual to tactual among contact behaviors are consistent with the organismic-developmental position (Werner and Kaplan, 1950) that a level of maturity attained by an individual or a group should not be conceived as a static or fixed pattern of operation for the genetic level of functioning may differ, depending upon the circumstances. Furthermore, the finding that the behaviors (search and visual contact) which decreased significantly under low illumination are those which gain dominance at a later and more advanced level lends support to the Jackson-Goldstein (1939) principle of hierarchical disintegration which states that operations which emerge later and are more complex are more susceptible to oscillation than those

which appear earlier and are simple. Also, other things being equal, the group which has most recently attained a particular level of functioning, e.g., the 19- in contrast to the 24-month-olds in the present study, is most likely to manifest a shift toward a lower level of functioning. Any attempt to understand how environmental variables affect attachment behaviors must take genetic levels into account. As shown by the present study, it is the genetic level of mode of organization which determines the level of functioning in attachment behavior under the impact of activating conditions.

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